Systems Performance Benchmarking

Presented by:

Nicholas A. Caronna, PE
Associate & Pharmatech Team Leader
CRB Consulting Engineers, Inc.
Cary, NC

Laboratories for the 21st Century

2003 Annual Conference – Denver, CO

October 23, 2003

Why Laboratories?

- Laboratories are Energy Intensive
- Consume up to 10x typical office building
- Most existing labs can reduce energy use by 20-30% with existing technology
- Save $$ and toxic emissions
- Optimize performance through integrated design and life cycle cost analysis.

The Engineering Challenge

- Labs must provide safety, typically minimal regard for energy use.
- An Interactive Design Process is required for a functional, sustainable facility.
- There may be Resistance to new ideas.

Life Cycle Cost Analysis

- Life Cycle Cost (LCC) Analysis is a method for selecting the optimum lab facility systems and evaluating options.
- Includes fuel costs, maintenance costs, operating personnel costs.

CFD Analysis

- Computational Fluid Dynamics (CFD) Analysis
  - ➢Helpful to understand airflow characteristics in a lab (or any space).
  - ➢Critical in Vivarium (Animal) Lab Facilities
  - ➢Low Velocity Diffusers and Locations
  - ➢User Impacts on Turbulence

Energy Reduction Opportunities

- Lighting
- HVAC
- Controls
- Building Envelope

Energy Reduction Steps

- Minimize the Load
  - ➢Reduce Air Volume
  - ➢Analyze Temperature & Humidity Rqmts.
  - ➢Review Code Rqmts.
  - ➢Review Eqmt. Plug Loads
  - ➢Consider Diversity
    - ❖Fume Hoods
    - ❖Climatic Part-loading

Energy Reduction Steps

- Right Sizing Equipment
  - Modular Plant Design (Summer Boiler)
  - High Efficiency Chillers, Boilers
  - Controls (setbacks)
  - VAV vs. CAV (save 40-60%)
  - Variable Speed Drives
  - Fume Hood Diversity (50% in use)
  - Small rooms should be sized for 100%
  - Be skeptical of Eqmt. Loads
- Safety First

Lab Exhausts

- Reduce Exhaust to lowest, safe level
- Avoid Excess Fume Hoods
- Consider Sash Options
- Review Room Airflow Patterns
- Fume Hood Energy Consumption
  - 6 ft. hood costs $4-7/CFM

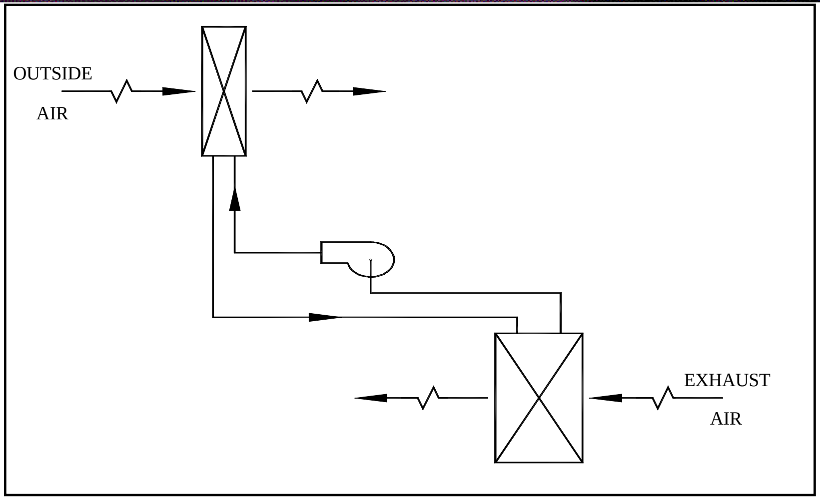
Energy Recovery #1
HX Re-Circulated Loop

Pros

- Simple Controls
  - Minimal Maintenance
  - Ease of Design and Installation
  - Cross-contamination is Eliminated

Cons

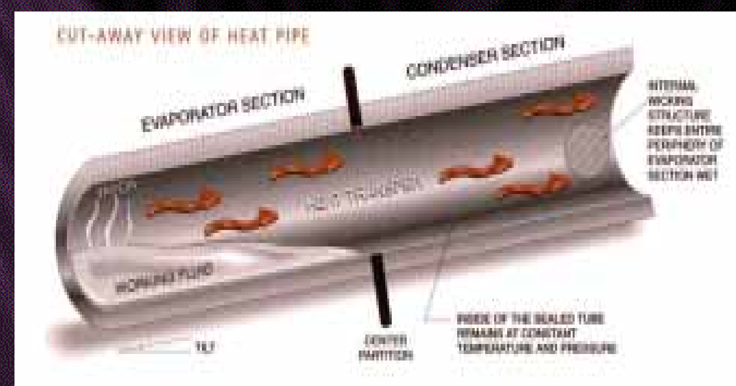
- Sensible Energy Recovery Only
- Relatively Low Efficiency



Energy Recovery #2
Heat Pipe

Pros
- "Zero" Maintenance
  - Simplest Design (i.e. minimal controls & motors)
  - Passive Energy Recovery
  - Cross-Contamination is Eliminated

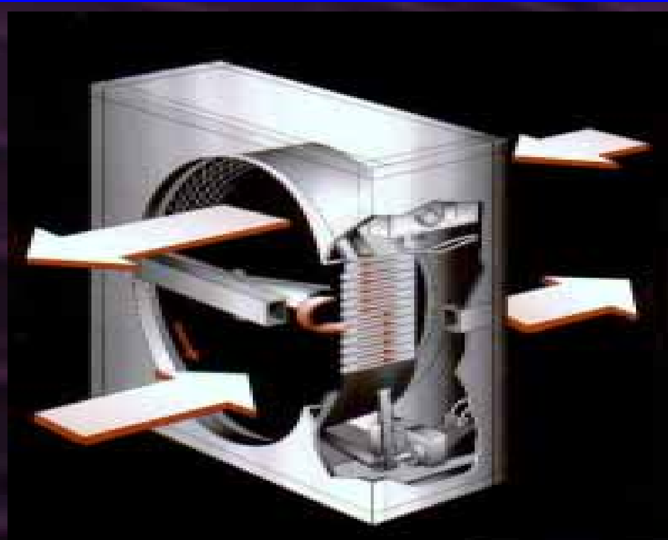
Cons
- Sensible Energy Recovery Only
  - Relatively Low Efficiency

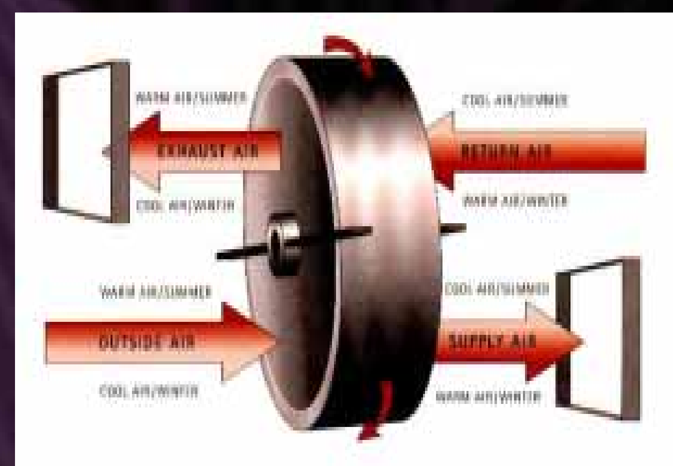


Energy Recovery #3
Heat Recovery Wheel

Pros
- Best Efficiency
- Recovers Both Latent and Sensible Energy

Cons
- Cross-Contamination Possible
- Limited Life Expectancy (i.e. wheel replacement, 2 to 5 years





Energy Recovery #4
Kathabar System

Pros

Good Efficiency

Recovers Both Latent and Sensible Energy

Winter-Time Humidification of Air

Cons

Relatively Complex (i.e. pumps, controls, piping)

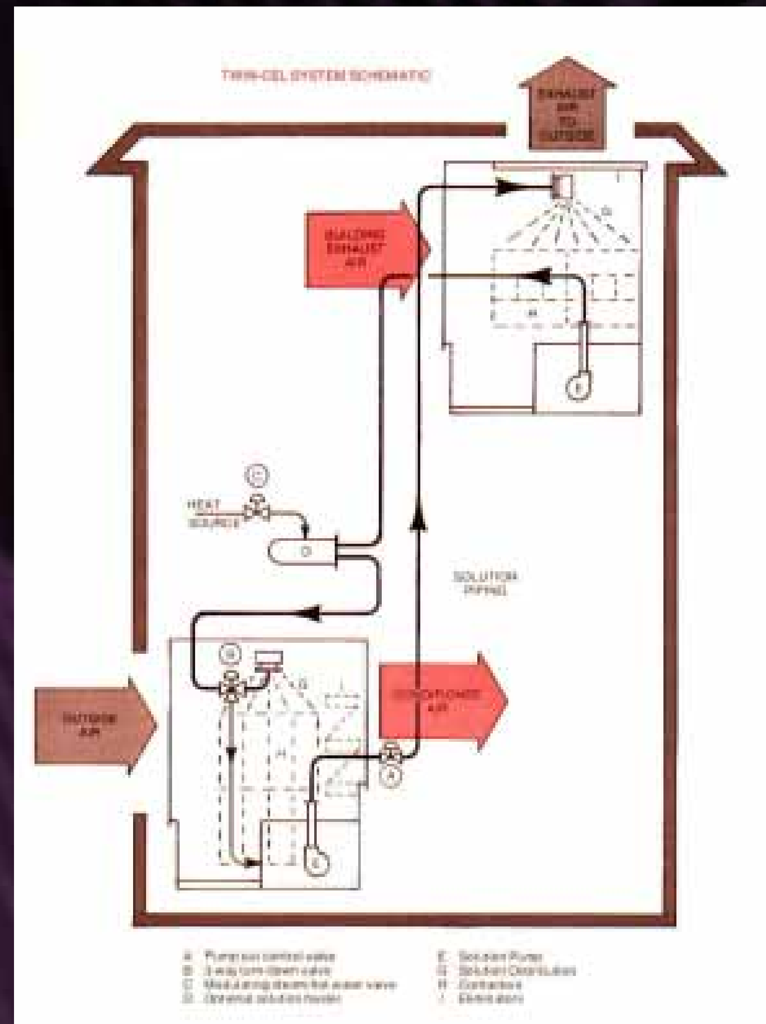
Fluid is Corrosive

High Airside Pressure Drop

Fluid Contacts Both Supply & Exhaust Air Directly

Large Footprint (i.e. larger mech. space)

Expensive First Cost



Annual HVAC Energy Operating Costs

Case Study Using Phoenix® Usage Based Controls System

Zone Presence Sensor

CV/RH System (13,000 cfm)	*$49,900*
VAV/RH System (5,200 cfm; ~40%)	$29,126
Actual VAV/RH with UBC (2,500 cfm avg.)	*$19,600*
UBC Savings Over CAV:	<u>$30,300</u>

40% of Maximum Flow Was Seen (some hoods @ 20%)

60% Operating Cost Savings Over CAV Seen

Lighting

- Lighting can represent the largest energy consumer.
- Pursue ambient and dedicated task lighting schemes.
- Use Occupancy/Photosensitive Controls
- Illumination Levels range from 30-100 fc
- Consider indirect/direct lighting

Lighting

- Consider Compact Fluorescent Lamps
- Occupancy Sensors can save 10-50%.
- Carefully Consider Placement in Lab
  – Parabolic Perpendicular to Benches
  – Indirect/Direct Parallel to Benches

Sustainability

- Building Envelope to Reduce Solar Load
  - Optimize Fenestration
  - Building Orientation
- Harvest Storm Water for Irrigation
- Harvest Gray Water for Irrigation
- Recover HVAC Condensate for Make-up
- Evaluate Sizes of Once-Thru Air Spaces

Sustainability (Cont'd)

- Lighting Types
  - Natural Daylighting
  - Occupancy Controls
  - More Task Lighting
- Materials of Construction
  - "Green" products, such as hardwood, veneer and plywood from certified, sustainable forests

Sustainable Lab Design Criteria

	TYPICAL LAB DESIGN	"GREEN" LAB EXPERIENCE
Lab Equipment Heat Dissipation	10-15 W/SF	8 W/SF
Lab Lighting	3 W/SF	1.5 - 2 W/SF
Office Lighting	3 W/SF	0.75 – 1.0 W/SF
Laboratory Power	10-15 W/SF	8 W/SF
Office Power	4 W/SF	2 W/SF
Compressed Air	5 scfm/outlet	1 scfm/outlet
DHW for Lab Sinks	3 gpm	2.25 gpm
DCW for Lab Sinks	3 gpm	2.2.5 gpm